Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Expanding the Economic and Innovation	)	Docket No. 12-268
Opportunities of Spectrum Through Incentive	)	
Auctions	)	

COMMENTS OF ALCATEL-LUCENT

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Alcatel-Lucent submits these comments in response to the above-captioned Notice of Proposed Rulemaking ("NPRM") seeking comment on moving forward with incentive auctions as authorized by the Middle Class Tax Relief and Job Creation Act of 2012 (the "Spectrum Act").

I. INTRODUCTION AND SUMMARY

Alcatel-Lucent is the trusted transformation partner of service providers, enterprises, and strategic industries worldwide, providing solutions to deliver voice, data and video communications services to end-users. A leader in mobile, fixed, IP and optics technologies, and a pioneer in applications and services, Alcatel-Lucent was named on *MIT Technology Review*'s 2012 Top 50 list of the "World's Most Innovative Companies"[1] for breakthroughs such as lightRadio™, which cuts power consumption and operating costs on wireless networks while delivering lightning fast Internet access. Through such innovations, Alcatel-Lucent is making communications more sustainable, more affordable and more accessible. In achieving these goals, Alcatel-Lucent leverages the unrivaled technical and scientific expertise of Bell Labs, a leading innovator in the communications industry.

[1] *See* MIT Technology Review, 50 Disruptive Companies, available at http://www2.technologyreview.com/tr50/2012/, visited Jan. 21, 2013.

With operations across the globe and the most experienced global services organization in the industry, Alcatel-Lucent is a local partner with a global reach. Alcatel-Lucent employs over 16,000 in the U.S., home to Bell Labs' global headquarters. Alcatel-Lucent's presence in the United States is central to its position as a world leader in emerging telecommunications technologies.

Alcatel-Lucent commends the Commission on issuing an NPRM setting out thoughtful proposals on truly difficult issues, many of which are issues of first impression. While these comments propose alternatives to several of the Commission's lead proposals, the NPRM has served as an invaluable spark, leading to intensive and cooperative efforts among the many stakeholders that stand to benefit from incentive auctions.

Successful incentive auctions to reallocate 600 MHz band spectrum for mobile broadband are critical to addressing our Nation's growing spectrum crunch. There is a growing demand for data-intensive mobile services, and -- along with the technological strides made by industry to efficiently use existing spectrum allocated to mobile broadband -- new spectrum is required to meet that demand. The success of the incentive auction also is vital to funding the nationwide interoperable public safety broadband network, recommended by the 9/11 Commission over a decade ago, but still facing many challenges.

To meet these goals, Alcatel-Lucent recommends that the Commission implement a band plan that maximizes the utility and value of the auctioned blocks, including changes that will maximize the Commission's ability to make increased amounts of paired spectrum available. Alcatel-Lucent interprets the Commission's proposed band plan, which includes a duplex gap and downlink and uplink blocks, as anticipating deployment of Frequency Division Duplex ("FDD") Long Term Evolution ("LTE") in the 600 MHz band. As such, the balance of

these comments emphasizes consideration of, and potential improvements and enhancements to, that FDD-focused proposal to facilitate a successful forward auction.

Notwithstanding the Commission's apparent anticipation of a primarily FDD approach to deployment in the band, Alcatel-Lucent recognizes a recently renewed industry interest in consideration of a band plan that facilitates the deployment of Time Division Duplex ("TDD") LTE in the band. In addition to FDD, Alcatel-Lucent believes a TDD approach to deployment also merits consideration. Particularly given continuing uncertainty over the amount of spectrum to be made available in the forward auction, there is the potential for an FDD band plan to yield only limited paired spectrum and substantial unpaired downlink spectrum. A TDD approach may better provide the maximum amount of spectrum with both uplink and downlink capabilities, which – on its own – makes TDD worthy of serious consideration. Ultimately, both FDD and TDD approaches to deployment in the band result in various benefits. Alcatel-Lucent continues to analyze a 600 MHz band plan configured to accommodate a TDD-only approach, and we anticipate providing additional technical analysis in our reply comments.

In the illustrative FDD plan provided at Figure 2 (*see infra* page 13), Alcatel-Lucent proposes an uplink block from Channel 51 down. It is recommended, however, that the uplink block down from channel 51 be limited to 25 or 30 MHz, due to concerns that a larger block would raise issues of third order harmonics into the PCS band as well as face filter limitations. Figure 2 further depicts the spectrum between that uplink block and Channel 37 being filled out by a 10 MHz duplex gap and 35 to 40 MHz of downlink spectrum. Alcatel-Lucent recommends against interspersing TV Channels between the wireless uplink and downlink blocks, as proposed in the NPRM, due to harmful interference concerns.

Channel 37, on which incumbent radio astronomy and medical telemetry services may continue, can serve as a natural break between additional unpaired downlink or uplink spectrum to form additional pairs, or TDD spectrum depending on which brings greater market demand (*i.e.*, which would raise maximum funds to meet the financial obligations set forth by Congress in the Spectrum Act).

In an FDD-based band plan, Alcatel-Lucent supports the Commission's focus on auctioning interchangeable 5 MHz blocks, but urges the Commission to account for the potential that not all valuable blocks may be treated as interchangeable by the market. For example, the ultimate FDD 600 MHz band plan may include both paired and unpaired spectrum blocks. There are other examples of spectrum blocks that, on their face, might be valued differently by bidders. In such a case, the Commission should consider designating "block classes" to account for lack of substitutability.

At some point, the Commission may determine that the benefits of auctioning spectrum that the market deems valuable are outweighed by concerns of auction design and complexity unique to incentive auctions. Indeed, the NPRM asks about potentially not auctioning certain spectrum at all that might be partially encumbered or otherwise fail to be interchangeable. Rather than forgo revenues altogether for desirable spectrum that the Commission would auction but for incentive auction complexity concerns, Alcatel-Lucent recommends that such spectrum can be held out of the initial incentive auction process and included in a subsequent forward auction. By auctioning that spectrum, the Commission could further help meet spectrum demand. Furthermore, while revenues from any subsequent forward auction(s) likely could not be used to meet closing conditions for the incentive auction, such

revenues could be used to satisfy the other financial obligations set forth in the Spectrum Act, including funding the nationwide interoperable public safety broadband network ("PSBN").

II. SUCCESSFUL INCENTIVE AUCTIONS COULD HELP REALIZE IMPORTANT NATIONAL GOALS

A. Incentive Auctions are a Valuable Tool to Address the Spectrum Crunch

The United States is facing a critical need for more terrestrial broadband spectrum. It is for this reason that the National Broadband Plan, issued in early 2010, recommended that the Commission undertake to make 500 MHz of spectrum available for broadband over ten years, with 300 MHz available for mobile use within 5 years.[2] The National Broadband Plan further estimated that 120 MHz of the 300 MHz identified for near-term reallocation to mobile broadband would come from broadcast television spectrum. Thus, successful incentive auctions are critical to meeting that goal, with the promise to fuel continued broadband innovation and investment to benefit consumers and the Nation's economy.

The need for spectrum continues to grow as more communications devices capable of supporting increasingly data-rich applications are used by consumers, enterprises, public safety agencies, and others. As of December 2012, worldwide, there are approximately 6 billion mobile subscriptions in a population numbering almost 7 billion individuals. The use of new mobile multimedia services, connected device applications and machine-to-machine services is expected to continue to grow, as the new wireless Internet Protocol infrastructures being implemented today set the stage for innovation and expansion of the wireless ecosystem.

Specifically, the main factors behind the mobile data explosion are:

- Video: According to a January 2012 Bell Labs study, by the year 2016, video streaming and video communication will account for almost 50% of all mobile traffic

[2] Connecting America: The National Broadband Plan at 87-88 (2010), Recommendation 5.8 at 84-85, available at hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296935A1.pdf.

in North America. This would represent a 5-year compound annual growth rate ("CAGR") of 95%.[3]

- Proliferation of Tablets and Smart Phones: In 2011, tablets and smart phones (43%) had drawn to about even with feature phones (46%) in the North American device mix (with the balance M2M). Even as the overall number of devices continues to grow, it is expected that, by 2016, tablets and smart phones will make up 59% of the mix compared to only 19% feature phones.[4]

- Application uptake: The rate at which applications are adopted is accelerating. Applications can go viral overnight. Apple just announced in January 2013 that 40 billion applications have been downloaded, 20 billion in 2012 alone. In 2012, the rate was equivalent to every person in the U.S. downloading over 64 applications per year.[5]

The telecommunications industry recognizes that, while more spectrum is essential to meeting rising demand, efforts to make technological advances are also underway. Alcatel-Lucent and others in the telecommunications industry have worked tirelessly to respond to demand and maximize the efficiency of the spectrum already allocated to mobile broadband. Some examples of industry ongoing efforts and successes include:

- Improving capacity through network densification, such as applying new network structure/topology to relieve data traffic congestion, particularly in urban areas. Alcatel-Lucent's LightRadio is a key enabler of network densification.

- Adopting more efficient mobile broadband technologies, such as LTE-Advanced. Among the features of 4G wireless technologies that will facilitate greater efficiency are Multiple Input Multiple Output ("MIMO"), Coordinated Multi Point ("CoMP") transmission, and Enhanced Inter Cell Interference Coordination ("eICIC"). Figure 1, below, illustrates the evolution of 3GPP technologies with their increasing levels of spectral efficiency.

- Offloading traffic to other networks, such as offloading of traffic via WiFi and Small cells/Femtocells, can provide some relief as traffic is re-routed to landline networks.

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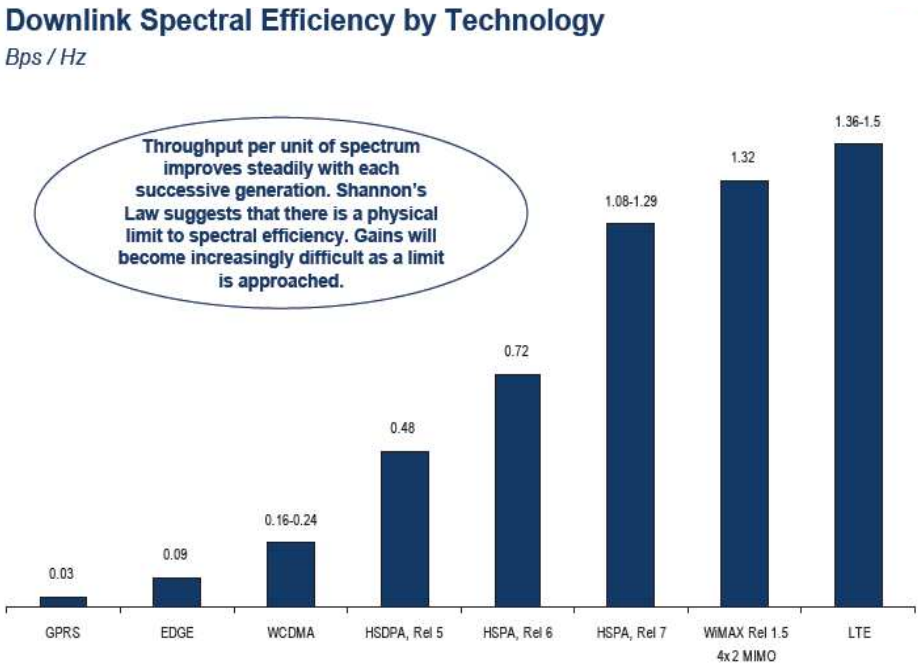
[3] Bell Labs, Network Planning, Performance and Economic Analysis Division, Mobile Data Traffic Indices, Feb. 10, 2012.

[4] *Id.*

[5] Apple press release January 7, 2013, http://www.apple.com/pr/library/2013/01/07App-Store-Tops-40-Billion-Downloads-with-Almost-Half-in-2012.html.



Source: Credit Suisse, February 2011

Figure 1 - Downlink Spectral Efficiency Trends

Although these and other innovations have resulted in more efficient spectrum usage and promise further spectral efficiencies, the trends reveal that, even as operators increase their capacity as well as the technological capabilities within a given piece of spectrum, new demands (especially high bit-rate) will require additional spectrum to fuel the evolution of mobile broadband technologies.

Furthermore, in this time of economic uncertainty, freeing up broadcast spectrum for mobile broadband is a critical ingredient to create jobs and enhance our global competitiveness. Chairman Genachowski recently praised the wireless industry as "innovators, investors and job creators," and recognized that, ". . . wireless has contributed to the creation of 1.6 million U.S. jobs in just the past few years. The mobile apps economy barely existed in early 2009. Today it alone supports nearly 500,000 jobs. Meanwhile, wireless contributes about $150

billion annually to U.S. GDP -- and growing."[6] In this proceeding, the Commission has the opportunity to create jobs and spur investment in a particularly concrete way. By acting quickly to reallocate broadcast spectrum for mobile broadband use through incentive auctions, the Commission proposes the most expeditious path toward near-term investment in our nationwide terrestrial wireless broadband infrastructure. In short, broadband investment means jobs.

B. Auction Revenues Are Critical to Funding the Nationwide Public Safety Broadband Network

In addition to the very important goal of reallocating scarce spectrum resources to mobile broadband, the Spectrum Act allocates $7 Billion of critical funding for a nationwide interoperable PSBN, a goal that has eluded our Nation for over a decade despite widespread support. As Commissioner Rosenworcel observed in her Statement to the NPRM:

> We must remember that in the [Spectrum Act], incentive auctions are part and parcel with enhancing public safety . . . . After far too many years, we are at long last beginning to address the 9/11 Commission's call to enable communications connectivity among local, state, and federal first responders.[7]

Alcatel-Lucent has been an early and unwavering proponent of the use of interoperable, open-standard, commercial broadband technologies in the U.S. Public Safety 700 MHz band to protect the life, health and safety of our Nation's first responders and citizens. Alcatel-Lucent's proposal on transforming the data portion of the U.S. Public Safety 700 MHz to a broadband-only block, made to the Commission in 2005, helped pave the way for a nationwide PSBN based on LTE technology.[8] While the telecommunications industry and policy makers have made great

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[6] Chairman Julius Genachowski, Prepared Remarks To International CTIA Wireless 2012, May 8, 2012.

[7] NPRM, Statement of Commissioner Jessica Rosenworcel at p. 199.

[8] *See* Comments of Lucent Technologies, Inc., WT Docket No. 05-157, filed Apr. 28, 2005.

progress, there is still a long road ahead with many choices and much uncertainty before the nationwide PSBN becomes a reality.

Among the major hurdles to achieving a nationwide PSBN is the funding intended to be generated by the incentive auction. As the NPRM recognizes, however, before funding can be made available for the PSBN, our Nation's first responders must stand in line behind the following substantial obligations: (1) payment to successful bidders in the reverse auction; (2) the cost of administering the incentive auction; and (3) the estimated amount of the relocation cost reimbursements that the Commission is required to pay to broadcast television licensees and multichannel video programming distributors.[9] These three items are express conditions to complete the incentive auctions, while funding for the PSBN is not. This underscores the importance not only of incentive auction proceeds meeting the statute's express closing conditions, but being successful enough to also fund the nationwide PSBN and other goals set forth in the Spectrum Act.

In response to the Commission's proposed band plan, which envisions deployment of FDD LTE, Alcatel-Lucent advocates concepts in these comments that maximize the number of spectrum blocks made available at auction and make those blocks as valuable as possible to bidders in the forward auction. Alcatel-Lucent agrees with the Commission that a core group of interchangeable blocks will yield maximum revenues. Where there are non-interchangeable blocks that would be desirable at auction, however, those blocks should also be auctioned to the maximum extent. Alternative courses of action, such as padding guard bands with desirable spectrum, must be weighed against the strong intent of Congress that incentive

[9] Spectrum Act, § 6403(c)(2)(C).

auctions raise sufficient funds for implementation of the nationwide interoperable communications capability our Nation's first responders so sorely need.

III. THE 600 MHZ BAND PLAN AND SERVICE RULES SHOULD MAXIMIZE THE UTILIZATION OF THE AUCTIONED BLOCKS

Alcatel-Lucent applauds the Commission's commitment to ensuring that the reverse auction portion of incentive auctions are as simple as possible to encourage broadcaster participation. The "Learn Everything About Reverse Auctions Now" ("LEARN") program and other outreach efforts show great promise as does the proposed reverse auction design. No doubt – incentive auctions cannot be successful without robust participation by broadcasters.

It is also important that the Commission maximize forward auction participation as well as maximize the value and utility of the spectrum at forward auction. To maximize the amount bid for each block, the forward auction bidders need certainty. There cannot be material risk that a bidder could win a block it finds significantly less valuable than others. Such risk would depress the overall amount any forward auction participant would be willing to bid, putting the auction, itself, at risk. With these overarching goals in mind, Alcatel-Lucent provides the following considerations and recommendations.

A. A TDD-Focused Band Plan

While the industry, along with Alcatel-Lucent, has focused the bulk of its efforts reviewing the Commission's lead proposal, featuring FDD spectrum pairings, in recent weeks, there has been increasing sentiment within the industry that the Commission should consider a TDD approach to the 600 MHz mobile broadband band plan. Alcatel-Lucent recommends that further study and consideration of a TDD band plan is appropriate. While different technologies present different challenges, they also present different benefits. Given continuing growth of congestion in mobile operator downlink spectrum, uncertainty with respect to the amount of

spectrum that will be available in a 600 MHz auction, and discomfort many stakeholders have voiced with an FDD band plan that limits the amount of paired spectrum blocks available at auction, TDD is a rational alternative to technology deployment in the 600 MHz band.

To implement a TDD-based band plan, there must be a minimum of 10 MHz of guard band between any TDD band and either uplink, downlink or TV broadcast bands. This is because at one time interval or another (measured in milliseconds) a TDD system will transmit or receive in its band and will cause the same sort of interference as, for example, an uplink band can cause to an adjacent downlink band and *vice versa*. Consequently, a 10 MHz guard band would be required between the lower 700 MHz band and 600 MHz TDD operations. A guard band separation would also be required between 600 MHz TDD allocations below Channel 37 and adjacent broadcast operations (10 MHz would be sufficient, although slightly less may also be feasible).

As an additional consideration, and for the same reasons described in greater detail related to FDD uplink operations, it is not recommended that TDD operate at 1/3 the PCS downlink band (643 to 665 MHz) where transmitting TDD user equipment ("UEs") would cause harmonic desensing of nearby PCS UEs during the TDD uplink transmissions. Alcatel-Lucent is equally concerned about third order harmonics into PCS for FDD uplink as it would be for TDD operations located at 643 to 665 MHz.[10]

A key benefit of a TDD band plan is that each individual auctioned block can serve the uplink and downlink needs of the carrier. In the event that an FDD approach to the 600 MHz band plan would result in an inordinate amount of downlink-only spectrum blocks being made available at auction, a TDD approach may serve as a compelling alternative. While

[10] One solution may be that, in the part of the band where third order harmonics are of concern, TDD operations could operate as downlink only, synchronized with adjacent TDD operations.

Alcatel-Lucent appreciates some interest in the acquisition of additional spectrum for downlink use in light of congestion and usage pressures on today's mobile broadband services, we also appreciate that we cannot with certainty predict tomorrow's killer application or how downlink and uplink traffic patterns may change over time. To that end, a TDD approach that preserves downlink and uplink flexibility is compelling.

An important consideration of TDD is that all adjacent spectrum operators within a TDD band must adopt compatible timing parameters such as duty cycle, uplink-downlink ratios, frame and subframe timing and common GPS synchronization with compensation for any timing offsets in their different equipment. This coordination must be done for all conceivably geographically overlapping networks, which will surely eventually be nationwide. Otherwise any license holder may be transmitting from base station while another is trying to receive on the adjacent frequency.

Alcatel-Lucent continues to assess TDD deployment in the 600 MHz band, and anticipates further technical comment in reply comments. The balance of these initial comments focuses on responding to the FDD-based approach as presented by the Commission in its NPRM.

B. Recommendations for a Proposed Band Plan with an FDD Core

Alcatel-Lucent's starting point for consideration is the Commission's proposal in the NPRM, an FDD band plan with all wireless uplink grouped from channel 51 down and all wireless downlink grouped from channel 36 down. After a substantial amount of study, we make the following observations regarding the Commission's FDD-based proposal as well as propose technical recommendations with respect to that proposal. Figure 2, below, depicts an illustrative example of an alternative FDD-based 600 MHz band plan.

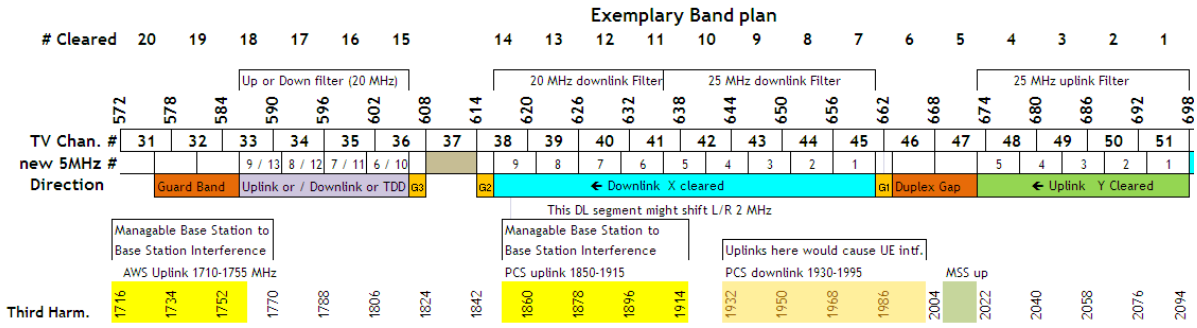

Figure 2 - Exemplary FDD-based band plan for illustration

Uplink band of 25-30 MHz from channel 51 (698 MHz) down. Alcatel-Lucent agrees with the Commission that, in an FDD-based band plan, the first wireless uplink spectrum segment should be allocated from TV channel 51 down in 5 MHz blocks. Starting with Channel 51 down provides the most efficient band plan as there is no need for a guard band interposed with the lower 700 MHz A block at 698 MHz.

Contrary to the Commission's lead proposal, however, Alcatel-Lucent respectfully submits that an uplink band from Channel 51 down cannot exceed 25 or 30 MHz. As shown in Figure 2, the PCS downlink band overlaps third harmonics generated by signals in the region from 643.3 MHz to 665 MHz. Consequently, terminals transmitting in this frequency range can cause interference in PCS band receivers that are located nearby.

Considering the body loss for both terminals, a new entrant's terminal transmitting, for example, at 650 MHz at 200 MWatts (23 dBm) can inject -26 dBm into a nearby PCS terminal's receive antenna. Non-linearities in the victim PCS's terminal front end will result in interference at 3x650 = 1950 MHz.[11] The 3GPP specification TS36.101 § 6.6.3.1 permits a spurious emission from the new entrant's terminal to be as large as -30 dBm/MHz,

[11] Other harmonics -- other than the third -- are also created, but these do not fall into the downlink bands of any of the existing eUTRAN bands, and they are typically substantially weaker than the third harmonic and third order intermodulation products.

which can be a major source of on channel interference to a receiver at 1950 MHz. In fact, this form of interference has been observed from lower-700 B and C block uplinks causing interference into AWS downlinks in the field. Consequently, the spectrum from 640 to 665 MHz should not be allocated to uplink operations because the third harmonics from the mobile terminals would cause third harmonic desensitization within PCS band terminals located nearby. This would permit no more than a 30 MHz segment of uplink blocks in the highest uplink segment.

A separate consideration may limit uplink below Channel 51 to only 25 MHz. Bandwidth limitations in existing SAW/FBAR filters may restrict the segment size to 25 MHz rather than 30 MHz, but future filter improvements or use of multiple filters may be used to support a 30 MHz segment.

The band plan should include a duplex gap with no TV channels interspersed with wireless operations. The Commission's lead proposal anticipates including TV Broadcast channels between Channel 37 and the wireless uplink block. Alcatel-Lucent recommends against this approach. While an analysis of UE blocking from TV transmitters in next to adjacent channels may suggest (incorrectly) that there is compatibility of interspersed TV transmitters between the new entrant's uplink and downlink bands, InterMod ("IMD") product interference proves more problematic to terminal receivers. Specifically, harmful interference arises from the terminal receiver intermodulation products which are caused by the terminal's transmit signal and a TV signal impinging upon a terminal's radio front end where images appear in the terminal's receive band.

According to a study authored by Nokia, a 50 kWatt ERP DTV station can inject a -23 dBm signal into typical UEs at distances from 0.4 to 3.5 km.[12] For a station transmitting at a full 1 MWatt ERP, this will be 13 dB worse. This level is much higher than the -44 dBm level permitted by the UE receiver with 10 MHz guard band between the desired 5 MHz LTE channel and the unwanted 5 MHz LTE channel within 15 MHz of the UE receive band. Under the Commission's proposal to include TV channels in the duplex gap between wireless uplink and wireless downlink, the UE's duplexer filters will attenuate this unwanted signal by only a limited amount, perhaps by 10 dB. This still permits an out of spec signal into the UE's radio from -33 to -20 dBm for the 50 kWatt and the 1 MWatt cases respectively. Because the actual UE receive antenna gain is lower than the measurement antenna gain, the DTV station carrier power received at the UE's low noise amplifier ("LNA") could be from -38 to -25 dBm. This TV signal mixes with the UE's own transmissions, which are typically about -25 dBm at the UE's LNA (+23 dBm minus duplexer filter isolation of about 48 dB).

These two signals, one from the TV station and the other from the UE's own transmitter, impinge on the UE's LNA input each at about -25dBm. The typical UE LNA has a third order input intercept point ("IIP3") of between -2.5 and -7.5 dBm. Taking the middle value of -5 dBm, Alcatel-Lucent calculates the intermodulation product as 2(TV – IIP3)+TX or 2(-25dBm - -5 dBm) – 25 dBm = -65 dBm, which is much larger than the typical sensitivity level of

[12] 3GPP TSG-RAN WG4 meeting #54 contribution R4-100430, "TV transmission power at UE antenna port." Accessed Jan. 10, 2013 at: http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_54/Documents/R4-100430.zip; Qualcomm has referenced an analogous study of lower-700MHz D&E block interference in earlier comments to the Commission. *See* Comments of Qualcomm Incorporated, WT Docket No. 12-69, June 1, 2012; Reply Comments of Qualcomm Incorporated, WT Docket No. 12-69, July 16, 2012.

about -100 dBm.[13] This -65 dBm intermodulation product essentially blinds the UE from receiving all but the strongest desired signal at the frequency where the product is generated, at $2 F_{tv} - F_{uplink}$. When this image frequency corresponds to the downlink channel, the downlink is greatly desensitized.

This InterMod product interference is particularly troublesome assuming the Commission implements its proposal to auction interchangeable blocks. A disciplined approach to pairing spectrum, restricting aggregating bandwidth, and TV channel allocations may control this interference scenario, but with substantial constraints on the use of the CMRS blocks. In particular, a TV channel at, say, channel 43 (644 to 650 MHz) will present an image of the first uplink channel (693 to 698 MHz) signal at: 2*(644 to 650)–(698 to 693) = 590 to 607 MHz. Consequently, just a single TV 43 channel can make the first uplink channel cause interference to the first through third downlink channels in the Commission's primary band plan proposal. Other combinations may work provided that there are no other interfering TV channels, but multiple TV transmissions can result in a many more cases of interference. It is far better that there be no allocation of TV stations within the duplex gap. This also solves the well known interference problem of UE interference into TV receivers operating on adjacent channels, such as the current TV channel 51 interference from the 700 MHz A block. *See* below for a detailed discussion regarding recommended guard bands, including guard bands between wireless operations and TV broadcast operations.

[13] This analysis does not include the further degradation from the modulated TV and LTE signals. In 3GPP contribution R4-125664, measurements of UE receiver IMD3 caused by 5 MHz LTE carriers with a realistic Peak to Average ratio have an IMD3 (falling into a 5 MHz channel) that is about 2 dB worse than CW tones. But the point is still made with the simpler explanation above.

Harmonics generated from base station emissions are manageable. Alcatel-Lucent has examined the other interference scenarios including second and higher order harmonics generated from base station emissions, and has determined that they are manageable. For example, base station emissions, even those with pristine harmonic filtering, can result in the generation of harmonics due to dissimilar metal junctions or metal filings in cable connectors, and even rusty bolts in the vicinity of antennas. As shown in Figure 2, base station transmissions between 570-585 MHz, 616.67-638.3 MHz and 668.3-673.3 MHz may generate interference into the uplink bands of the AWS, PCS and MSS S-bands respectively. To manage this potentiality, operators will deploy new equipment with separate cabling and antennas so that the antenna isolation will help to reject any third harmonics. But since existing antennas in the field do not currently support frequency bands below 600 MHz, this is not a troublesome requirement.

Up to 45 MHz of core downlink spectrum above channel 37; leaving existing operations at channel 37. As discussed above, technical interference and filtering issues limit the amount of uplink spectrum above Channel 37 to 25 to 30 MHz. Moreover, Alcatel-Lucent recommends against including TV broadcast channels above Channel 37. As such, as depicted in Figure 2, Alcatel-Lucent recommends that, below the uplink block, the band plan include a duplex gap (no larger than technically reasonable) followed by 40 to 45 MHz of downlink spectrum. This would provide the greatest number of 5 MHz blocks for auction above Channel 37, resulting in 5 or 6 paired spectrum blocks and 3 or 4 unpaired downlink spectrum blocks.

Either additional uplink blocks, additional unpaired downlink blocks or TDD blocks are feasible below channel 37. Alcatel-Lucent recommends that the spectrum below Channel 37 could be used either for downlink, uplink, or TDD. As described in greater detail below, there are arguments in favor of each of these choices, and within the context of the

Commission's proposed FDD-based band plan, the ultimate decision should be based on the demand of potential bidders for more downlink or uplink spectrum blocks or TDD blocks.

Addressing channel 51. As the Commission recognizes, there currently are significant unresolved issues related to the coexistence of 700 MHz Lower A Block operations and channel 51.[14] This proceeding presents a perfect opportunity to clear channel 51 of broadcast operations. Alcatel-Lucent urges the Commission to make addressing channel 51 -- clearing that channel of broadcast television operations -- a priority.

C. The FCC Should Strive for Interchangeable Blocks, but Should Also Make Accommodations for Auction of Non-Interchangeable Blocks

One of the key drivers in the Commission's band plan approach in the NPRM is creating interchangeable blocks at the forward auction to simplify the bidding process. Alcatel-Lucent agrees that auctioning interchangeable blocks appears critical to increasing the speed of the forward auction substantially, providing significant benefits to reverse auction participants and forward auction participants alike. Alcatel-Lucent therefore advocates for making interchangeable blocks the centerpiece of the forward auction.

The Commission also recognizes however that there will be instances where certain valuable blocks may not be interchangeable and asks whether the Commission should offer such blocks for auction. Alcatel-Lucent recommends that the Commission should make every effort to auction commercially attractive spectrum blocks, even those blocks that the market indicates are *not* interchangeable. To facilitate this, the Commission should consider (i) designating more than one "block class" in the forward auction and (ii) in limited instances,

[14] NPRM, ¶ 165.

holding a subsequent forward auction for any valuable spectrum blocks that limitations of incentive auction design indicate cannot be auctioned as part of the initial process.[15]

Before discussing these alternatives, it is important to evaluate a particular block's potential desirability/value at auction. There may be valid reasons to determine certain spectrum is not suitable for auction. The Commission should not auction spectrum where there is not anticipated to be sufficient demand for the auction to be successful. However, for all spectrum that has a market at auction, the default assumption should be to auction that spectrum.

Block classes. The primary example where block classes might be appropriate would be to account for the different valuation of FDD paired spectrum blocks versus downlink only spectrum blocks – or, if spectrum is not auctioned in pairs, the potentially disparate value of uplink blocks versus downlink blocks. A licensee's existing holdings in the AWS band or PCS band may also lead to economic tradeoffs in how harmonically related blocks in the 600 MHz band are deployed. Another example may be the potential for so-called "remainder spectrum." As a final example, the Commission also posits a number of other scenarios that might make certain geographies more encumbered than others, such as where there may be exclusion zones to protect incumbents or where the licensee would be required to endure increased interference. For such situations, the NPRM indicates that such geographies may be measured to determine the level of encumbrance, some of which might have limited enough issues to be considered

[15] Forward auction participants may have valid preferences for certain blocks that in isolation appear interchangeable. For example, for a given operator with holdings in other AWS or PCS bands, some 600 MHz blocks are more usable than others. It would be impossible for the Commission to account for all such individualized situations without completely abandoning interchangeability. To address this issue, the right of license holders to trade blocks in after-market transactions is critical. Subsequent to auction completion, winning bidders should have the opportunity to request specific blocks and trade blocks in private arrangements, upon completion of the auction to account for individual spectrum needs.

"clear." But, perhaps, the next grade down would still be desirable though not necessarily interchangeable with "clear" geographies and should be auctioned as its own block class.

Subsequent forward auction. If incentive auction complexity does become a barrier to auctioning certain spectrum blocks during the initial incentive auction process, that need not be the end of the discussion. The Commission should not refrain from auctioning the spectrum, but rather set the spectrum aside for subsequent forward auction (or auctions).[16] Granted, revenues from any such subsequent auctions likely could not be taken into account with respect to incentive auction closing conditions. But if the choice is to forgo auction revenues forever because of issues of auction design and complexity or to set such spectrum blocks/geographies aside until after the incentive auctions close, the choice is clear. The Commission should not leave valuable spectrum on the table, which could help fund the multiple financial obligations set forth in the Spectrum Act.

D. Guard bands Must Be Sufficient, But No Larger Than Technically Necessary

The Spectrum Act requires that the "guard bands shall be no larger than is technically reasonable to prevent harmful interference between licensed services outside the guard bands."[17] The Commission further has indicated block interchangeability as one of its five policy goals, and issue of critical importance to provide certainty in the forward auction.[18] Taken together, it is necessary as a legal and practical matter that the Commission provide sufficient guard bands (and duplex gaps) to ensure that licensed operations adjacent to those guard bands are not disadvantaged compared to licensed operations further away.

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[16] While the Spectrum Act authorizes the Commission to hold only one reverse auction, there is no express limitation on the number of forward auctions. Spectrum Act § 6403(e).

[17] Spectrum Act, § 6407(b).

[18] NPRM at ¶ 125.

Alcatel-Lucent strongly opposes proposing guard bands dependent on up to 8 MHz of "remainder spectrum" to make them large enough to provide adequate protection for licensed services. Conversely, use of "remainder spectrum" to make guard bands as much as 4 MHz *larger* than technically reasonable to protect licensed operations, as suggested in the NPRM, would be unlawful.[19]

Alcatel-Lucent proposes guard bands below that are large enough to meet these requirements.

No guard band is needed between 600 MHz uplink and lower 700 MHz uplink. In the NPRM, the Commission proposes no guard band between the 600 MHz terrestrial uplink band and the existing lower 700 MHz terrestrial uplink band. Alcatel-Lucent agrees that, as long as power limits, emission limits and antenna height restrictions for the proposed 600 MHz uplink band and the existing 700 MHz uplink band are comparable, these adjacent operations are harmonized and, therefore, no guard band is needed at 698 MHz.

The duplex gap between wireless uplink and wireless downlink should be between 10 and 12 MHz. As detailed in the IWPC submission in this proceeding[20] and confirmed by Alcatel-Lucent's discussions with terminal filter manufacturers, it is currently difficult to make terminal filters with duplex gaps narrower than about 1.5%, which suggests slightly more than 10 MHz (1.5% of 668 MHz is 10.02 MHz) at the high end of the band.

[19] Of course, there may arise a circumstance where remainder spectrum is so limited and of such limited utility that auction of that spectrum is not warranted. However, padding guard bands should not be the first course of action for valuable spectrum blocks in the Commission's inventory for auction.

[20] Presentation of the International Wireless Industry Consortium, Docket No. 12-268, Nov. 27, 2012.

Alcatel-Lucent understands from its discussions with filter manufacturers that 10 MHz can be accommodated.[21]

In fact, several bands are currently served with duplex gaps less than 1.4% fractional bandwidth, though at some performance cost. A slightly larger duplex gap, such as the 12 MHz duplex gap depicted in the exemplary band plan at Figure 2, could be allocated to making the duplex filter "easier," with better performance such as bandwidth and insertion loss. Any lower frequency duplex filters, such as below Channel 37 support 10 MHz duplex gaps with even greater ease as this scales with frequency. For example, a duplexer at 596 MHz would have a fractional duplex gap of 1.7%, comfortably more than 1.5%.

The guard band between 600 MHz uplink and television should be greater than 6 MHz but need not exceed 10 MHz. Alcatel-Lucent believes that 6 MHz is insufficient to protect against interference between TV broadcast operations and wireless UEs. For example, Figure 3 below depicts a commercial filter currently supporting the lower-700 MHz A block by filtering out TV channels 50 and 51 as much as possible while passing A block. Despite strong design business pressure, small and cost effective filters today cannot suppress band 51 much at all, and not much of band 50 either. It clearly shows that a guard band narrower than 10 MHz is not commercially produced at this time.

[21] If there were 6 Uplink blocks allocated, then the center of the duplexer would be moved down 5 MHz to 663 where the calculation suggests that it is relatively easy to make a duplex gap of 1.5% of 663 = 9.95MHz. This has the added benefit of making a low loss filter with a bandwidth of 30 MHz somewhat easier to produce.

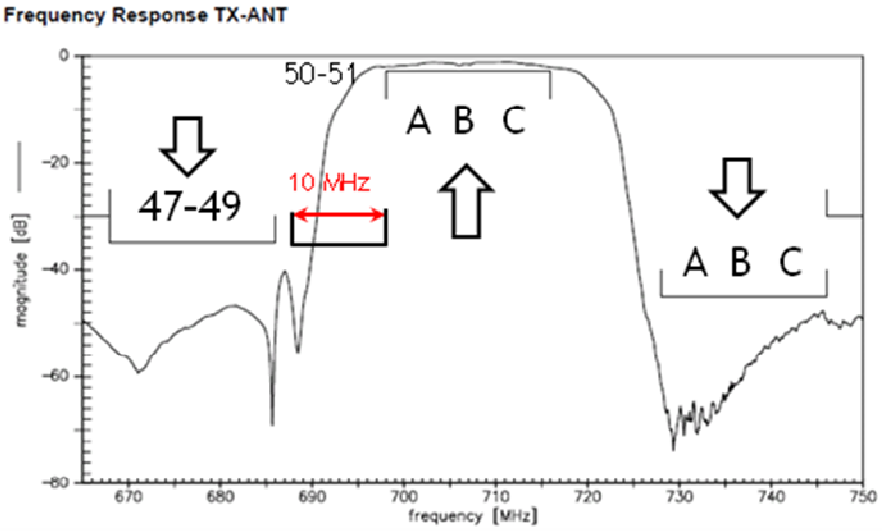

Figure 3 - Frequency Response of commercial EPOS filter for 3GPP Band 12 illustrating the need for 10 MHz guard band[22]

Consequently, Alcatel-Lucent recommends a 10 MHz guard band (although slightly less may be feasible), which is likewise supported by the previously cited IWPC report.[23] Even so, many broadcasters operate at power levels lower than 1 MWatt ERP. Alcatel-Lucent respectfully suggests that the Commission could optimize the 600 MHz band plan by assigning stations already operating at less-than 1 MWatt ERP to channels adjacent to the guard band separating TV Broadcast and wireless services. In that way, the Commission could minimize the requisite guard band size between these services, increasing the amount of returned spectrum that could be auctioned.

The guard band required to mitigate interference from 1 MW ERP DTV station Tx to 600 MHz UE Rx should be greater than 6 MHz but need not exceed 10 MHz. Based upon the same Nokia and Qualcomm studies cited above, [24] a 50 kWatt ERP DTV station has

[22] See EPCOS production filter B7931. The data sheet is available at: http://www.epcos.com/inf/55/db/B7931.pdf

[23] Presentation of the International Wireless Industry Consortium, Docket No. 12-268, Nov. 27, 2012.

[24] *See*, supra, footnote 11.

been seen to inject a -23 dBm signal into typical UEs at distances from 0.4 to 3.5 km. For a station transmitting at a full 1 MWatt ERP station, this will be 13 dB worse. Because the actual UE receive antenna gain is lower than the measurement antenna gain, the DTV station carrier power received at the UE could be -15 dBm. This level is much higher than the -44 dBm level permitted by the UE receiver with 10 MHz guard band between the desired 5 MHz LTE channel and the unwanted 5 MHz LTE channel within 15 MHz of the UE receive band. The UE receive filter needs to provide at least 29 dB (-15 - -44 = 29 dB) of attenuation of the DTV interferer. Consequently we recommend at least a greater-than 6 MHz, but no more than 10 MHz, guard band between DTV and CMRS downlinks.

Any operations permitted in guard bands or duplex gaps must not adversely affect auctioned spectrum blocks. As noted above, Congress authorized the Commission to include guard bands in the 600 MHz band plan "to prevent harmful interference between licensed services outside the guard bands."[25] Congress further authorized the Commission to potentially permit services in the guard bands, but also specified that the "Commission may not permit any use of a guard band that the Commission determines would cause harmful interference to licensed services."[26] Beyond this statutory mandate, the Commission also must consider its stated goals to auction interchangeable blocks. If the Commission auctions spectrum adjacent to guard bands as interchangeable, it is imperative that bidders agree that those bands are not disadvantaged due to their proximity to any services permitted in the guard bands.

E. Additional Technical Issues Raised in the NPRM

The band plan should be based on 5 MHz blocks. Alcatel-Lucent supports the Commission's proposal to license the 600 MHz spectrum in 5 MHz building blocks to the extent

[25] Spectrum Act § 6407(b).

[26] *Id.* § 6407(d).

it pursues a final band plan that accommodates FDD deployment. LTE, the industry choice for roll-out of next-generation broadband wireless networks, supports channels sizes as small as 1.4 MHz, but channels of 5 MHz and larger provide greater efficiencies and capabilities to provide robust services. Notwithstanding this preference, to the extent smaller blocks are available, resulting from remainder spectrum or otherwise, the Commission should consider auctioning those blocks as well. Five MHz blocks, however, should serve as the core block size in the 600 MHz Band plan in an FDD-centric approach.

Alcatel-Lucent also strongly urges the Commission to guarantee that bidders that win more than one 5 MHz block obtain blocks that are adjacent to each other, permitting the carrier to operate using wider channels and greater throughput than a single 5 MHz block would allow.

If an FDD band plan is chosen, Alcatel-Lucent supports a band plan that provides both paired and unpaired blocks for auction. In the NPRM, the Commission proposes a band plan that includes unpaired downlink spectrum in order to maximize the amount of spectrum that can be made available, and as a practical consequence of a reverse auction that may not produce enough spectrum for an exclusively paired approach to the forward auction. Technology allows for carriers to make valuable use of unpaired downlink bands. The LTE-Advanced standard, for example, has incorporated features to allow for carrier aggregation across bands with asymmetry between uplink and downlink carriers in select bands.

Moreover, traffic patterns indicate a substantially greater need for downlink capacity compared to uplink capacity today. The average traffic payload in wireless networks appear to be increasingly "downlink heavy" by a factor of about 8 to 1. Forecasts indicate that streaming video to subscribers will likely continue to be the leading growth application for smart

phones. Thus, it appears that downlink traffic will continue to grow in importance, while uplink traffic grows less rapidly.

An additional consideration relative to the efficacy of unpaired downlink spectrum being made available at auction, uplink traffic is more amenable to additional technical solutions for gaining spectral efficiencies. The centralized power of the network, with multiple base stations, can retrieve signals with greater sensitivity and diversity than can a handset receive the downlink. Advanced signal processing techniques such as CoOperative Multipoint ("CoMP") and Inter-Cell Interference Cancellation ("ICIC") are being developed to improve the spectral efficiency of the uplink, while the downlink spectral efficiency is already quite close to the Shannon bound as seen in Figure 1, above.

Notwithstanding the potential demand for unpaired downlink blocks, the Commission recognizes industry demand for paired blocks,[27] and proposes to pair licensed spectrum where possible. There are any number of reasons potential bidders would prefer to acquire paired blocks over unpaired blocks. The need for uplink spectrum would be especially acute for new entrants and other carriers with limited spectrum holdings. There is also no guarantee that traffic patterns will continue to trend as they are. Who knows if the next "killer app" will be uplink intensive in ways not yet considered? [28] As such, notwithstanding today's downlink-heavy trend, certain bidders may prefer paired spectrum to account for potential future developments, and the Commission must factor these needs into its final band plan.

[27] NPRM ¶ 132.

[28] For example, at this year's super bowl football game, there was more uplink traffic than downlink, as fans uploaded photos and videos of the event. Such scenarios remain rare however, and require unique provisioning in today's networks. "Super Bowl drives supersized wireless traffic," by Roger Cheng, February 7, 2012, available at http://news.cnet.com/8301-1035_3-57372694-94/super-bowl-drives-supersized-wireless-traffic/.

With those factors in mind, Alcatel-Lucent urges the Commission to adopt a band plan that makes as much paired spectrum available as possible, with any unpaired downlink blocks immediately adjacent to paired downlink blocks. This would provide the best avenue for auctioning the maximum amount of spectrum in an FDD-focused band plan.

Alcatel-Lucent further agrees that, to account for anticipated different levels of clearing in different markets, an FDD band plan should provide fixed downlink bands across markets to the greatest extent possible with variable uplink bands when less spectrum is available. As the Commission recognizes, user devices are less able to handle variations in downlink bands from market to market, thus arguing for keeping the downlink band constant. Moreover, current traffic patters demonstrate a more immediate need for downlink capacity. As such, it makes sense from a demand perspective that any asymmetry should favor downlink spectrum at this time.

The market should decide whether the spectrum below Channel 37 should be designated for uplink, downlink, or TDD. As noted above, and on a market-to-market basis, forward auction demand for paired versus unpaired spectrum remains an open question. Based on technical band plan limitations described above, and specific to an FDD approach, Alcatel-Lucent recommends a band plan that includes 5 uplink blocks and 9 downlink blocks (or potentially 6 uplink blocks and 8 downlink blocks) between Channel 37 to Channel 51. At Channel 37 there is a natural gap, below which either uplink, downlink, or a TDD approach is feasible. For 19 Channels cleared, it is possible to have 4 uplink blocks below Channel 37 and achieve exact symmetry in an FDD plan: 9 pairs. If the market values paired spectrum sufficiently over unpaired spectrum, that band plan should be chosen. As an alternative, for the same amount of spectrum cleared, the band plan could include 4 downlink blocks below channel

37, resulting in 5 paired blocks and 8 unpaired downlink blocks. As a third alternative, even if the Commission implements an FDD-focused band plan, the spectrum below Channel 37 could still be reserved for TDD use. Alcatel-Lucent urges the Commission to base its ultimate allocation decision on which of the options would raise more money to meet the multiple financial obligations set forth in the Spectrum Act. Paired blocks, unpaired blocks, or TDD are feasible from a technical perspective, and thus the market should determine the ultimate band plan.

Pass band size. As described above in discussing proposed band plan concepts, at the high end of the band 25 MHz is currently achievable economically and may soon improve to 30 MHz. At the low end, below TV Channel 37, a bandwidth of 25 MHz is appropriate with current technology.

OOBE limits. To address potential interference within the 600 MHz band, the Commission proposes to apply Section 27.53(g) of the Commission's rules, governing out of band emissions ("OOBE") in the lower 700 MHz band to operations in the new 600 MHz wireless band. The typical 43+10Log(P) OOBE limits for like services applicable to the 700 MHz band are appropriate here as well. OOBE limits into adjacent 600 MHz services such as the television bands, medical telemetry, and 700 MHz CMRS services are appropriately kept the same as current limits for CMRS equipment.

Power limits. The Commission proposes to apply the lower 700 MHz power limits (but not power flux density limits) to the 600 MHz band and modify the lower 700 MHz rules for the predetermined 600 MHz uplink and downlink bands. Alcatel-Lucent supports this proposal.

Antenna height. The Commission proposes to apply to new wireless operations in the new 600 MHz band the flexible antenna height rules currently applied in the 700 MHz band. Alcatel-Lucent agrees with the Commission's proposal, consistent with current practice.

Cross-border coordination. Current treaty arrangements and those under review with Canada and Mexico will apply to this band much as they do in the 700 MHz band where cross-border co-channel interference requires geographic isolation. The Commission might consider inviting contesting parties to create a joint Radio Network Planning team that would be able to better coordinate co-siting and antenna orientation coordination. To mitigate cross-border co-channel interference from base station to terminal and from terminal to base station, it is often most advantageous to place coordinated interferers on the same tower, back to back, so that the worst interference level occurs where the desired signals are the strongest, but this requires tight coordination of site selection. However, this coordinated co-siting cannot alleviate cross-border co-channel interference from base station to base station, which could be reduced by buffer zone and low base station antennas.

In cases with cross-border co-channel interference between base station and terminal, rather than fall back onto simple geographic exclusion zones, use of ground level limitations of Power Density may be most efficient.

IV. CONCLUSION

Alcatel-Lucent urges the Commission adopt the foregoing proposals in its implementation of incentive auctions and the new 600 MHz wireless band plan and service rules.

Respectfully submitted,

Alcatel-Lucent

/s/

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